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The BULK HANDLING of GRAIN

HANDLING grain in bulk is more economical than handling it in bags. Bulk handling saves time and labor, reduces the cost of handling, eliminates the cost of the bags and twine, avoids waste from leaky bags, promotes ease and accuracy of inspection, and facilitates the conditioning of grain.

To obtain full benefit from bulk handling, farm storage and country and terminal elevators must be equipped with the necessary machinery for handling bulk grain expeditiously. Efficient farm equipment consists primarily of grain-tight wagon or auto-truck boxes for hauling bulk grain to storage on the farm or to the market, portable elevators for handling the grain to and from farm storage, and bulking attachment for the combine.

Farm storage is essential for best results. It may consist either of portable bins, permanent granaries, or farm elevators. Which of these to use depends largely upon the quantity and kinds of grain grown on the farm.

Washington, D. C. Issued October, 1922

THE BULK HANDLING OF GRAIN.

With special reference to the Pacific Coast States.

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DEVELOPMENT OF BULK HANDLING.

THE handling of grain in bulk is becoming universally recognized as the most economical grain-handling system known. The economy in bulk handling is due chiefly to the fact that grain flows readily and that by utilizing the action of gravity, supplemented by mechanical means, grain may be handled practically without manual labor and at a speed impossible to attain with the bag system. The highest degree of economy in bulk handling results only when the grain is continuously handled in bulk from the thrashing machine to the mill or to a vessel for export. The merits of bulk handling are recognized by all grain-producing countries, and at present there is a widespread movement toward the adoption of this system of handling grain.

The bulk handling system usually replaces the laborious bag-handling system as soon as the grain produced in any locality exceeds its local needs and the surplus has to be shipped to other markets. It is the principal system now used in the large grain-producing sections east of the Rocky Mountains. In the Pacific Coast States a combination of conditions has, until recently, retarded the change from bag handling to bulk handling, so that at present burlap bags are still used to a great extent for handling grain. Bulk handling is growing in favor in the Pacific Coast

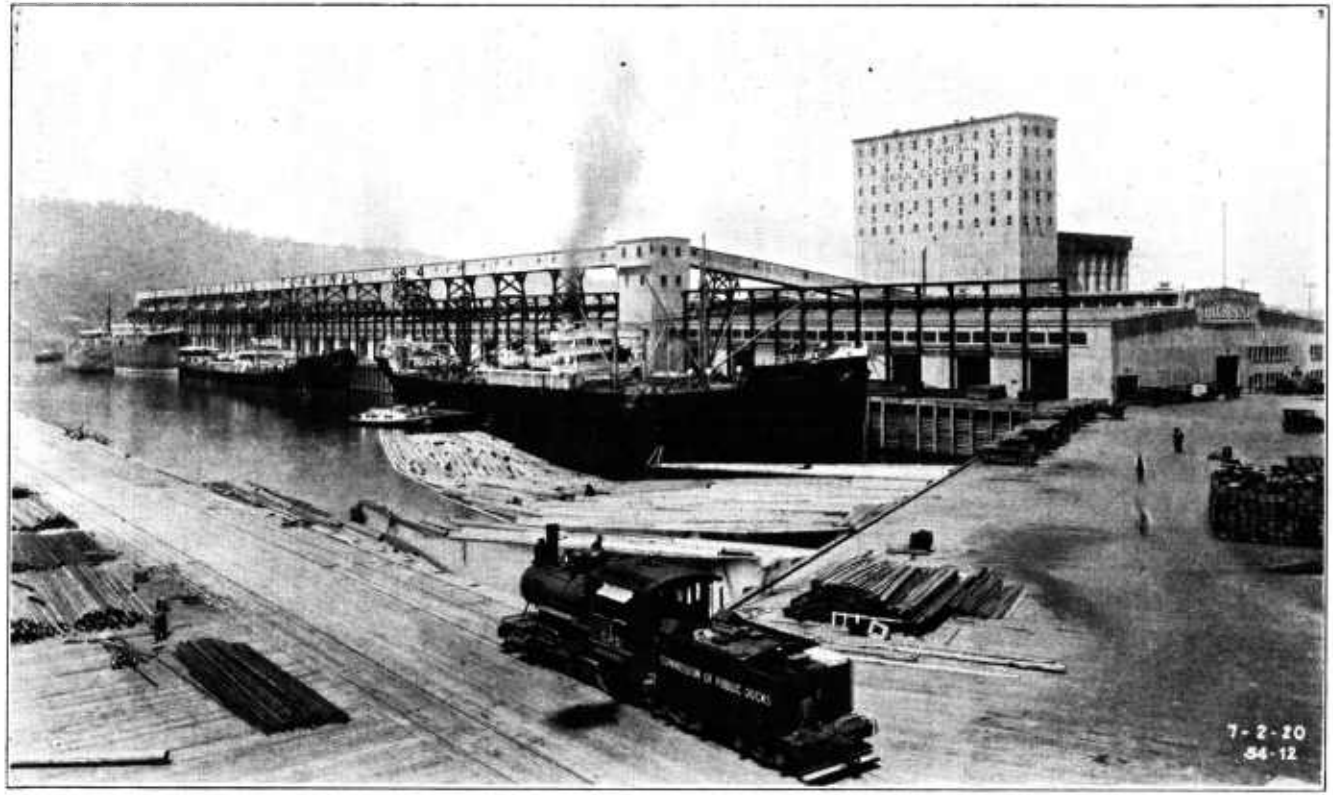

FIG. 1.—Terminal grain elevator.

States, and there is little doubt that bulk handling will be put in general practice in that section as soon as progressive farmers and grain dealers get a better understanding of its economic advantage and have time to make the necessary changes from the bag to the bulk system.

Large terminal elevators, equipped for receiving, handling, conditioning, and delivering grain in bulk into railroad cars, or into vessels for export, are now located at each of the Pacific coast seaboard markets. Many cargoes of grain have been successfully exported in bulk from the Pacific coast during the last year. A Pacific coast terminal elevator is shown in Figure 1, and the method of loading bulk grain into a vessel is shown in Figure 2.

FIG. 2.—Loading bulk grain into a vessel at terminal elevator.

ADVANTAGES OF BULK HANDLING.

The full advantages derived from the bulk handling system are realized only when the grain is handled in bulk and by appropriate machinery each time it is moved, from the time it leaves the thrashing machine until it is delivered to a mill or on board a ship for export.

The chief advantages of bulk handling are the saving of time and labor, the reduction in the cost of handling, the elimination of the cost of the bags, the prevention of waste from leaky bags, the ease and accuracy of inspecting the grain, and the convenience with which bulk grain can be conditioned and cleaned.

TIME AND LABOR SAVED.

The difference between the bulk and bag methods in time and labor required to handle a given quantity of grain is clearly shown by the

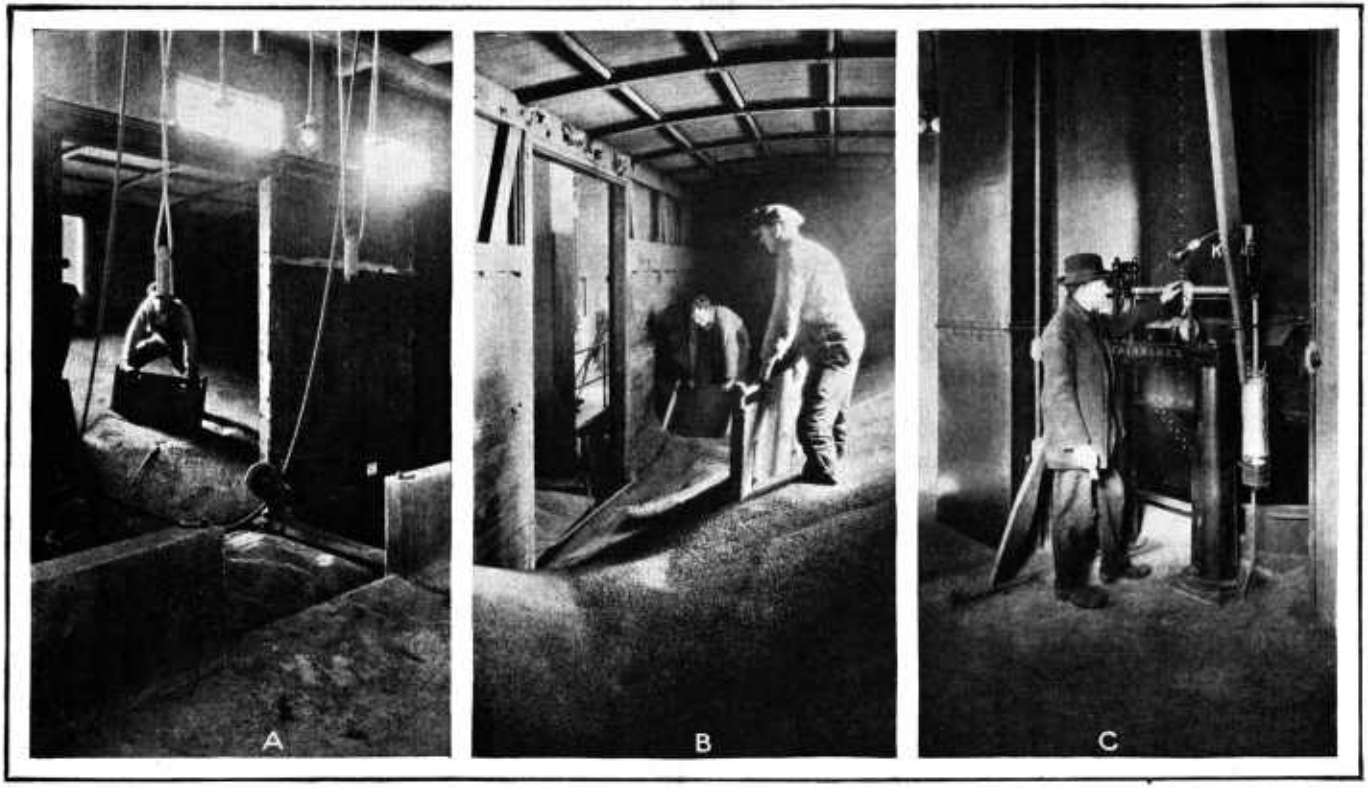

FIG. 3.—Unloading grain in bulk. *A* and *B*—Bulk grain being discharged from a railroad car with power shovels. *C*—Weighing the bulk grain.

results of investigations conducted in 1921 and 1922 in connection with the unloading of cars of grain at a modern terminal elevator and sack warehouse in Portland, Oreg. An average of 45.6 minutes was required for two men to unload cars containing an average of 1,346.4 bushels of bulk grain, and an average of 76.3 minutes was required for 15 men to unload cars containing an average of 1,207.8 bushels of bagged grain. These figures include the time required for spotting the cars, breaking out, handling the grain, cleaning out the cars, and placing the bulk grain in an elevator bin or piling the

FIG. 4.—Unloading grain in bags.

sacked grain 12 sacks high in the warehouse. Thus in the unloading of cars of equal size bag handling consumes more than twelve times as much manual labor as bulk handling.

A method of unloading and weighing a car of bulk grain is shown in Figure 3, and a common method of unloading a car of bagged grain in Figure 4.

The time and labor saved on the farm by handling grain in bulk is even more striking than the saving at terminal points, for the reason that usually no mechanical equipment such as hand trucks and piling machinery can be used. Grain properly handled in bulk on the farm requires little human effort, whereas when the grain is handled in bags the bags must be sewed, lifted, and carried to the sack pile. Later the bags must be unpiled and carried to and placed

on a wagon to be hauled to a country warehouse or to a place of safe storage on the farm. If the grain is harvested by a combine it is customary to collect the bags from the field with teams and low wagons and pile the bags on the edge of the field, where they will be easily accessible when it is convenient to haul them to market. This repeated handling of heavy bags of grain requires an immense amount of time and labor. Only men capable of performing the heaviest kind of work are suitable for handling grain in bags.

COST OF HANDLING REDUCED.

The difference between the bulk and bag methods in the cost of handling grain is also clearly shown by the results of investigations. These cost investigations were conducted at the same time and place as those to determine the time required for unloading cars of bulk grain and bagged grain.

These investigations show that for power and labor it cost $3.43 per car to unload, elevate, and place in bin, cars averaging 1,346.4 bushels of bulk grain, and that it cost $12.35 per car to unload and pile 12 sacks high in a warehouse, cars averaging 1,207.8 bushels of bagged grain. Thus the cost for unloading and piling bagged grain is four times the cost of unloading and placing in bins an equal quantity of bulk grain. Assuming that these figures represent a fair average for all the grain unloaded at the terminal markets in the Pacific Coast States, an enormous saving could be made on this item alone within the year by handling all the grain in bulk. These figures applied to a 200,000,000-bushel Pacific coast crop of grain would result in a saving of approximately $1,500,000 at the terminal.

The reduction in the cost of handling grain on the farm due to changing from the sack to the bulk method would depend somewhat on the harvesting and thrashing methods used. With a stationary thrasher the wages of sack sewers and jigger would be saved as well as the work and time of rehandling the sacked grain when hauling to market. Where combine harvesters are used there would be, in addition to the savings mentioned above, the saving of work and wages of men and teams required to collect the sacks of grain from the field and pile them at a convenient point for hauling to market. An investigation made at a stationary thrasher in 1921 showed that the extra labor cost of sack thrashing amounted to approximately 2 cents a sack. A common rate for collecting sacks after a combine and piling them near a road is 2 cents each, and 1 cent a sack is a fair estimate of the cost for each extra handling of sacked grain. This would amount to a saving of at least 2½ cents a bushel by handling grain in bulk from a combine.

Grain dealers in eastern Oregon who operate sack warehouses in connection with their elevators have stated that the labor cost for receiving sacked grain in the warehouse is six times the labor cost of receiving the grain in bulk at the elevator.

COST OF BAGS AND TWINE ELIMINATED.

The cost of the bags is a large item of expense in bag handling. Burlap bags, which are used almost exclusively for grain in the Pacific Coast States, have had a wide range in price in the last few years. The price of these bags in normal times ranges from about 8 to 10 cents apiece, but it was much higher during the war.

No definite information is available as to the actual amount the price of bags adds to the expense of bag handling, but it is thought that a conservative estimate of this expense to the farmer would be 2 to 4 cents a bushel. On this basis, assuming that the total crop of the Pacific Coast States is handled in bags, the cost of bags each year to the farmers of that section would amount to approximately $4,000,000.

Farmers should not be misled by the differential of 3 cents a bushel between the price of sacked and bulk wheat. It is true that wheat in bulk is penalized to that extent, but it is just as true that the farmer buys the sack and gives it to the man who buys his wheat. Trading is based on sacked wheat in the Pacific Northwest.

Twine may seem like an insignificant item to mention, but at the price charged for twine for sewing sacks in 1921 it becomes an item worthy of notice. Probably at no time, even during the war, when sacks cost 20 to 30 cents each, did twine cost the farmer as much as during the harvesting season of 1921. An investigation showed that although sacks were bought in the 1921 season by the farmers for 7 to 10 cents each, twine cost them from $1.25 to $1.75 a pound, approximately four times prewar prices. As there are about 175 strands to a pound of twine the cost for twine would amount to close to one-half cent a bushel.

WASTE FROM LEAKY BAGS PREVENTED.

The quantity of grain actually lost or wasted in bag handling is much greater than that lost by bulk handling. This condition should be considered when the cost of handling grain by these methods is being compared. The greatest loss in bag handling is caused by the grain wasted while the bags are being sewed on the combine and by leaky bags during handling and transportation to market. It has been estimated by persons who have made observations on the loss in handling bagged grain from the combine that an average of about

2 pounds of grain for each bag is lost before it reaches the warehouse.[1] The loss is attributed to the shuffling of grain from the floor of the "dog house" by the bag sewers, failure to brush the grain off the top of the bags before dumping them from the combine, the bursting of bags in the field and on the wagon, and damage to the bags from mice before they are removed from the field. It was estimated also that there is on the average a loss of 14 tons, or 0.5 per cent, in shipping a barge load of 2,500 tons of bagged grain from San Francisco to Stockton, Calif., and that for every 500-ton barge load there is usually a loss of 2,000 to 4,000 pounds, or 0.2 to 0.4 per cent. These losses are attributed to the handling of leaky bags. The grain from leaky bags falls on the warehouse floor and is cracked by the truck wheels and laborers during the handling of the bags to and from the warehouse. This is shown in Figure 5.

FIG. 5.—Waste from leaky bags.

EASE AND ACCURACY OF INSPECTION.

The ease and accuracy with which inspection may be made is much greater in the case of bulk grain than in bagged grain. There is much less chance for fraudulent practices when the grain is delivered in bulk to the place of inspection. A representative sample of bulk grain is more readily obtained than in the case of bagged grain. These factors are important in respect to the time and expense involved in marketing because grain is usually bought or sold on grades. All interstate shipments of wheat, shelled corn, and oats, when moving from or to an inspection point and sold by grade, must be sampled and graded by a Federal licensed grain inspector.

Figure 6 shows how a representative sample of bagged grain is obtained, and Figure 7 shows how a representative sample of bulk grain is obtained from a railroad car.

[1] Some Observations on the Bulk Handling of Grain for California, University of California Circular No. 152. 1916.

CONDITIONING OF GRAIN FACILITATED.

Bulk handling facilitates conditioning grain which is dirty, damp, or otherwise in need of treatment for the reason that cleaning machinery, which is of necessity a part of a well-equipped elevator, can be installed with economy of space for efficiently handling bulk grain either from the wagon to the bins or from the bins to a railroad car. Dirty or damaged grain in bulk may be improved in quality and condition more readily and with less expense in elevators than in warehouses where grain is stored in bags and must first be bulked and then rebagged after cleaning.

EQUIPMENT FOR BULK HANDLING.

Bulk handling, to be most successful, requires adequate farm equipment and country and terminal elevator facilities. The ele-

FIG. 6.—Sampling sacked grain.

vators should be of sufficient size and have enough storage bins to keep grain of different kinds and grades separate. The elevating machinery should be of sufficient capacity to handle the grain rapidly. Cleaning machinery should be installed with capacity sufficient to clean the grain as it is taken into the elevator. A competent grain buyer and elevator manager who understands the different grades of the various grains, and who has had experience in the handling and marketing of grain, should be put in charge of each elevator.

FARM EQUIPMENT.

The farm equipment necessary for best results in the handling of bulk grain in the Pacific Coast States consists primarily of

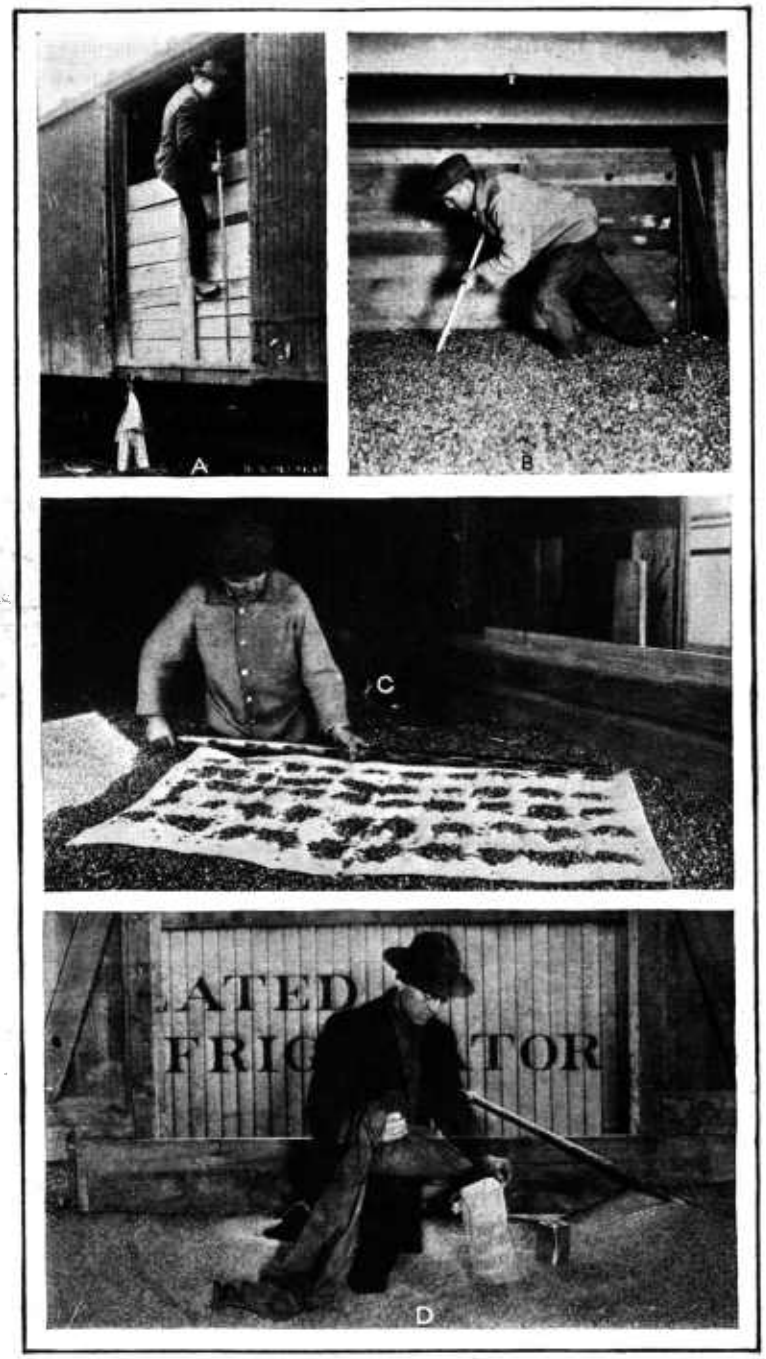

FIG. 7.—Sampling bulk grain. (A) Sampler entering the car, (B) probing the grain, (C) examining the probe samples, (D) placing sample in bag.

wagons or auto trucks equipped with grain-tight boxes, portable elevators, and bulking attachment for combines.

GRAIN-TIGHT WAGON BOXES.

Grain-tight wagon boxes are necessary if grain is to be handled entirely in bulk. These may be built on the farm or procured from the local farm-implement dealer. In the large producing areas of the Middle Western States the standard-sized wagon boxes which are made to meet general farm needs are used for hauling bulk grain. These wagon boxes are satisfactory in those States. However, special wagon boxes have been designed for use on many of the farms in the Pacific Coast States where bulk handling has been adopted. These special wagon boxes are built longer and deeper than the eastern standard boxes, giving them capacities ranging from 125 to 140 bushels. These are the most satisfactory sizes, as they hold about the maximum loads that may be conveniently hauled over the average country road. The boxes are usually built 12 feet long and for standard-gauge wagons. Boxes of much shorter length would, in order to give them sufficient capacity, have to be built so high that they would be top-heavy, and those of much greater length would require heavier construction and would be difficult to handle on the elevator dumps.

FIG. 8.—Flaring-side wagon box.

Two types of special wagon boxes are in common use. They are known as the flaring-side and straight-side boxes. The flaring-side box is more generally used, and has the advantage of a greater capacity than the straight-side box of equal height and length. The straight-side box, because of its simple construction, is more economically built and is less apt to develop grain leaks than the flaring-side box. A flaring-side wagon box is shown in Figure 8, and a straight-side wagon box in Figure 9.

The "dump" end gate for wagon boxes used for hauling bulk grain is practically indispensable, because it materially shortens the unloading process. Factory-built wagon boxes usually are equipped with "dump" end gates, but there is a tendency to omit them when the wagon boxes are constructed on the farm. Several types of these end gates are in common use, all opening in about the same manner, the main difference being in the way they are fastened

or unfastened. A type of "dump" end gate used in the flaring-side wagon box is shown in Figure 10, and another type in Figure 8.

FIG. 9.—Straight-side wagon box.

AUTO TRUCKS.

The auto truck has become an important factor in our transportation system. Auto trucks are commonly used for hauling grain

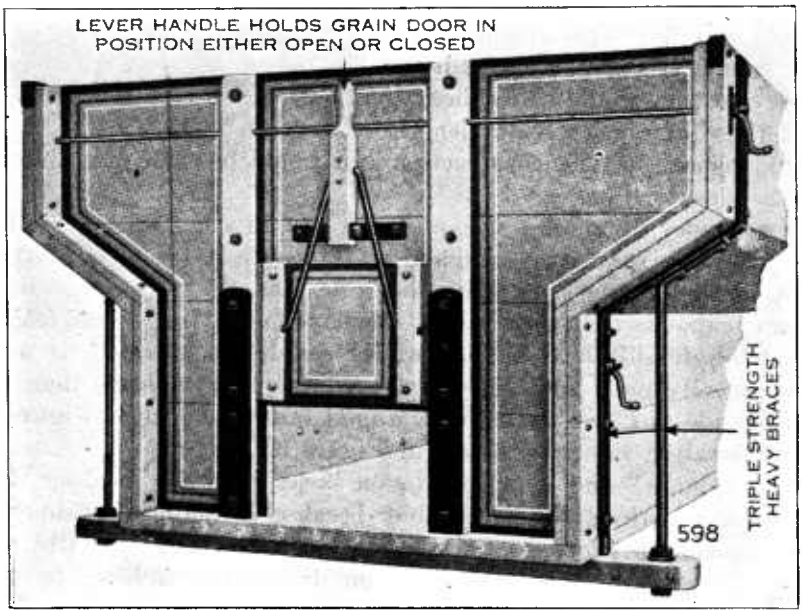

FIG. 10.—Dump end gate.

from the field to granaries, shipping points, and local markets. Where small trucks are used for delivering bulk grain to the ele-

vator, they may be unloaded on the ordinary wagon dump, but large trucks require special facilities. However, where large trucks are commonly used the elevators have provided means for unloading them. The difficulty of unloading large trucks may be overcome by the use of either hopper-bottom boxes or self-dumping devices.

Truck boxes with hopper bottoms have proved satisfactory for unloading bulk grain. These boxes are provided with a gate at the bottom of the hopper which when released allows the grain to flow into the elevator dump pit. To unload a box of this type with a capacity of 150 bushels requires from three to five minutes. Figure 11 shows an auto truck with a hopper-bottomed box. Auto trucks with self-dumping devices are more expensive than the ordinary types, and the economy of using them depends largely upon the extent of the general farm work for which they may be employed.

FIG. 11.—Auto-truck box with hopper bottom.

PORTABLE ELEVATORS.

A portable elevator is a power-driven machine used for handling bulk grain to and from farm storage. It consists of three parts, namely, a receiving hopper, an elevator leg, and an overhead wagon dump. The receiving hopper and the elevator leg are usually mounted together on either a truck or skids for convenience in moving them when desired. A gasoline engine usually supplies the power for operating the elevator, but it may be operated by horse power.

The receiving hopper is so arranged that it may be raised out of the driveway to allow the load of grain to be driven into position for unloading. Then the hopper is lowered into place to receive the grain as it flows from the wagon.

The overhead dump consists of a steel or wooden arch about 9 feet high, equipped with a windlass, cables, and pulleys. The wagon to be unloaded is stopped with the front wheels directly under the arch. The ends of the cables are made fast to the hubs of the front wheels and power is applied to the windlass, which elevates the front end of the wagon to the desired height. The grain flows out of the wagon into the receiving hopper after the end gate is removed. The windlass may be operated by hand or by power. Unloading may be done without the use of the overhead dump by shoveling the grain out by hand, but that requires more time and

labor. A portable elevator and overhead dump are shown in Figure 12.

Several types of portable elevators are in use. These differ mainly in the construction of the elevator legs and the methods of carrying the grain forward. One type has two legs or trunks placed parallel, which are joined together at the top and bottom. A pulley is placed at each end of the joined leg and an endless belt fitted with cups travels around these pulleys, carrying the grain up one leg. The cups empty as they pass over the upper pulley and descend the other leg. This type is suitable for elevating all kinds of small grain and it usually is operated in a vertical position.

Another type has a single leg which resembles a flat-bottom trough. A pulley or sprocket is placed at each end of the trough. A belt

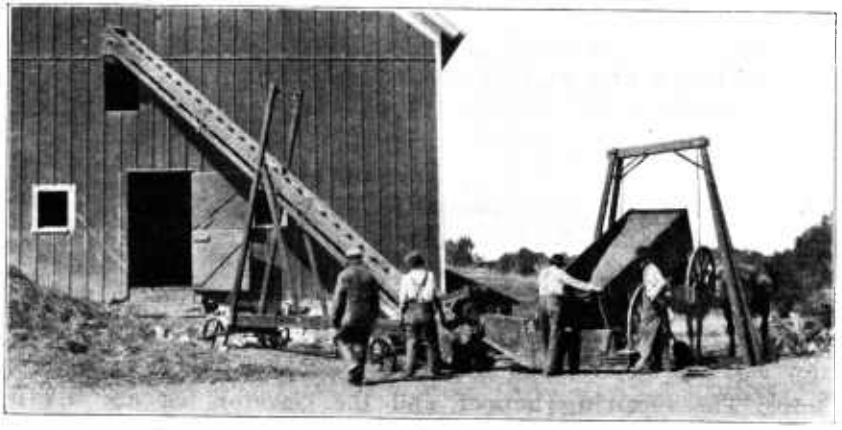

FIG. 12.—Portable elevator and overhead wagon dump.

or chain fitted with crossbars of either wood or steel travels over these pulleys. The leg is set at an angle and the crossbars push the grain ahead of them to the upper end of the trough, where it is discharged into a bin or wagon box. This type of elevator can not be operated efficiently at an angle much greater than 45°, because of the small quantity of grain that can be kept ahead of the crossbars as they move up the trough. This type is used principally in handling ear corn.

Still another type of portable elevator has a leg consisting of steel tubing about 6 inches in diameter. Round pieces of steel plate are attached to an endless chain and so fitted into this tube that they fill the opening and carry the grain forward as the chain revolves around sprockets at the top and bottom of the tube. An elevator of this type will handle small grain and shelled corn, and it may be operated efficiently at as great an angle as 60°. Portable elevators ordinarily have a capacity under normal conditions ranging from 500 to 600 bushels hourly.

The advantages of the portable elevator are the elimination of labor and the saving of time in handling grain. These elevators are made to handle all kinds of grain and they are used with equal advantage either to deliver grain into storage bins from wagons or to deliver grain into wagons from storage bins. When a large quantity is to be handled a portable elevator is practically indispensable because of the saving of time and labor.

BULKING ATTACHMENT FOR COMBINES.

Combines which are constructed to handle thrashed grain in bags may, with a few minor changes and some added equipment, be fitted to handle grain in bulk. These changes may consist either of the extension of the elevator leg of the combine to a length which will permit the grain to flow through a spout directly into a wagon box drawn alongside the combine, or the attaching of a hopper to the combine to provide temporary storage for the grain. Usually an elevator attachment is used for transferring the grain from the hopper to the wagons. When the hopper is omitted it is necessary to have wagons continuously with the combines to receive the grain as it is harvested and thrashed. When hoppers are provided for temporary storage on the combines, wagons need not continuously accompany the combine. With a hopper of sufficient size to hold a wagonload, one less wagon will be required to move the grain from the combine to the granary. This temporary storage provided on the combine is particularly necessary in a hilly country, where portions of the fields are so rough that it is impracticable to keep a wagon alongside the combine. The rapid transfer of the grain from the hopper to the wagon is desirable.

These storage hoppers are made in stock sizes and may be obtained from any farm-implement dealer who handles combines. They range in capacity from about 20 to 150 bushels. A farming corporation in California using the largest sized combines has equipped them with storage hoppers with a capacity of 150 bushels. This corporation uses 5-ton auto trucks to haul the grain from the combines to the elevators, and with the use of the large storage hoppers the saving made is equivalent to the services of one man and one truck.

FARM STORAGE.

Farm storage for grain is usually considered indispensable for best results on most farms. In the Middle Western and Eastern States, where the bulk handling system is used, farm storage of grain is a well-established practice. In the Pacific Coast States, where bag handling prevails, and where the weather is more favorable than in

other sections for grain left unprotected in the field, farm storage so far has been greatly neglected. When the distance is short the grain may be hauled directly from the thrashing machine to market, but even in such cases emergencies may arise, such as shortages of labor, teams, cars, or storage space in elevators, when farm storage becomes essential. It is an established fact that under average conditions farm storage may be maintained with less expense than storage space can be bought from a public warehouse or elevator. The fact that the grain is protected from weather damage as soon as it is thrashed would alone merit the adoption of farm storage.

Farm storage may consist of portable bins, permanent granaries, or farm elevators. Which of these kinds is best and cheapest depends largely upon local conditions, such as the quantity and condition of the grain to be stored, and the kind of material available for constructing the storage. Damp grain may be conditioned more readily in a granary or elevator when facilities for such work are available, than it can be if stored in bags.

PORTABLE BINS.

Portable bins may be constructed of either wood or steel, and are so built that they may be moved from place to place as desired. The rectangular frame bins are in common use, no doubt because of their simplicity of construction. Portable bins may be of "knock-down" construction or built on skids for convenience in transporting them intact from one location to another. They range in capacity from 500 bushels to 1,500 bushels.

Portable bins of the "knock-down" type are used in sections where the topography of the country is such that it is impracticable to move them intact. These bins are constructed in such manner that they may be taken down, loaded on a wagon and hauled to the location desired, and reassembled or stored away until needed the following season. Because of the difficulty experienced in keeping these bins grain-tight, they are not so desirable as the rigidly constructed bins.

Galvanized iron or steel bins provide satisfactory storage for bulk grain. They are vermin, fire, and rain-proof, easy to handle, and their cost is not prohibitive. Because of their light weight they are, when mounted on skids, easily moved from one field to another. If steel bins are not properly installed, they may be seriously damaged by the wind, because of the light weight material used and the large wall area presented to the wind. Therefore, the installation should be complete with all rafters and supporting members in place, as specified by the manufacturer. These bins are rigid and durable when properly built and mounted on and anchored to a substantial platform. A common type of gal-

vanized iron bin is shown in Figure 13. It is essential that these bins be strongly braced to withstand wind pressure when they are empty.

The main advantage in using portable bins for grain storage is the fact that they may be located alongside the stationary thrashing machine, as shown in Figure 14, which permits the grain to run directly into storage, thereby saving the expense and necessity of immediately hauling the grain to storage. Portable bins furnish a convenient and quickly-provided form of storage and they are usually resorted to in emergency cases, or as a pioneer method until a permanent form of storage can be built.

FIG. 13.—Galvanized-iron bin set up in the grain field.

Where large quantities of grain are stored it is doubtful whether the use of portable bins is economical. Permanent storage may be provided in the form of either a granary or a farm elevator at a cost not greatly exceeding the cost of portable bins of an equal capacity. The life of the ordinary grain bin is much shorter than

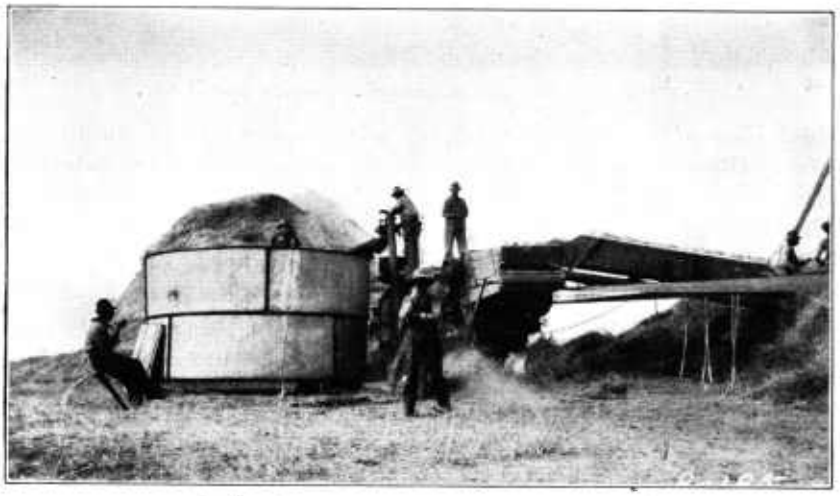

FIG. 14.—Portable sheet-iron bin at the thrashing machine.

that of the permanent forms of storage because it is more or less damaged in relocating each year and is apt to be neglected while not in use.

PERMANENT GRANARIES.

A permanent granary is a structure substantially built on a firm foundation and used primarily for storing grain. It is usually near the other farm buildings, but local conditions may make it desirable to locate the granary at some other place on the farm. For example, it may be located more favorably with respect to the grain fields, thereby shortening the haul from the thrashing machine; or it may be located with respect to roads, grade conditions, and distance to market, which would be an advantage in marketing the grain; or a hillside may be available for the location, permitting the handling of the grain by gravity to and from storage. The type of granary used is also a factor in determining its location. Many types of farm granaries are in use, each being constructed according to some individual idea of meeting and taking advantage of local conditions. Some of these granaries have very unique arrangements for handling grain.

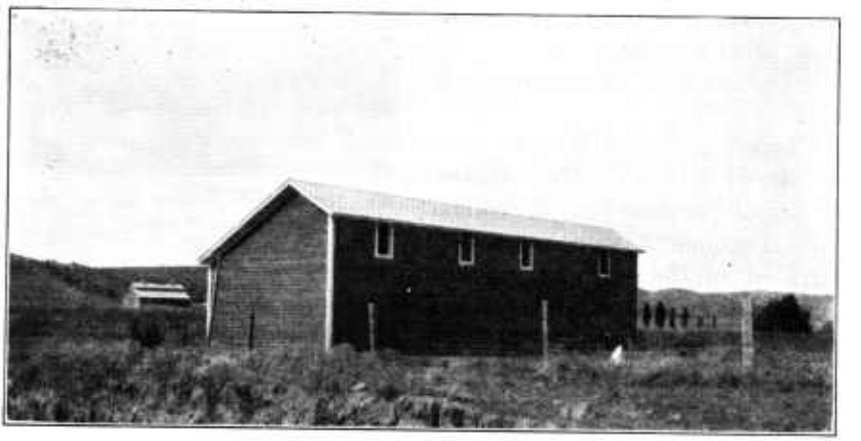

FIG. 15.—The type of granary commonly used.

The type of granary commonly used for farm storage is of frame construction and of a size that will meet the needs of individual farms. Figure 15 shows the most common type. The granary should be divided into a sufficient number of bins of the proper size to provide separate storage for each kind of grain produced on the farm and for the different grades of each kind.

Hillside granaries are designed to take advantage of the force of gravity. They are located against a hillside and constructed in such a manner that the grain is carried wholly or in part by gravity to and from the granary. This type is desirable and should be used where the lay of the land affords such advantage. (See Fig. 16.) The greater part of the manual labor is eliminated and no machinery is required to handle the grain in and out of these granaries. However, each hillside granary has to be designed to conform to the contour of its particular location.

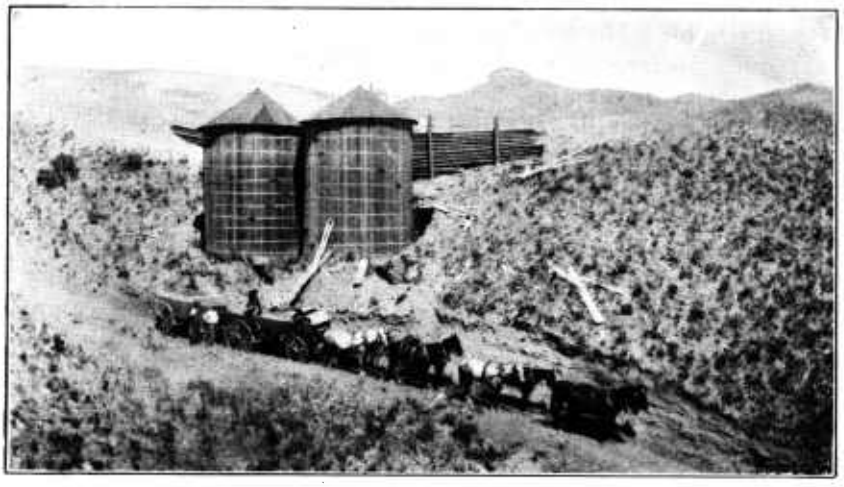

FIG. 16.—Hillside granary.

FARM ELEVATORS.

The farm elevator was developed to meet the needs of the large grain-producing farms. These elevators usually have a much greater capacity than the farm granaries and are equipped with machinery which will handle and condition the grain as required on the individual farm. The size of the elevator and the number and size of bins depend largely upon the quantity, kind, and condition of the grain handled. The farm elevator should provide at least ample storage for all the grain grown on the farm at the time it is constructed, and provision should be made for future increase if such is likely to take place. The elevator is usually conveniently located on the farm, but if a railroad track location is possible within reasonable distance from the farm it is highly desirable.

FIG. 17.—Farm elevator, capacity 6,000 bushels.

The farm elevator and the country station elevator differ mainly in the number of storage bins and the size and amount of mechanical

equipment which is needed to handle the grain properly. The farm elevator supplies the needs of an individual farm only and may not require so large a number of storage bins or machinery of so great capacity to handle the grain properly as does the country elevator, which handles the grain for a whole community. A common type of farm elevator is shown in Figure 17.

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